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(71) Applicant *(for all designated States except US)*: A. CELLI NONWOVENS S.P.A. [IT/IT]; Via Romana Ovest, 212, I-55016 Porcari (IT).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: CELLI, Alessandro [IT/IT]; Via Micheloni, 20, I-55015 Montecarlo (IT).

(74) Agents: MANNUCCI, Michele et al.; c/o UFF. Tecn. Ing. A. Mannucci S.r.l., Via della Scala, 4, I-50123 Firenze (IT).

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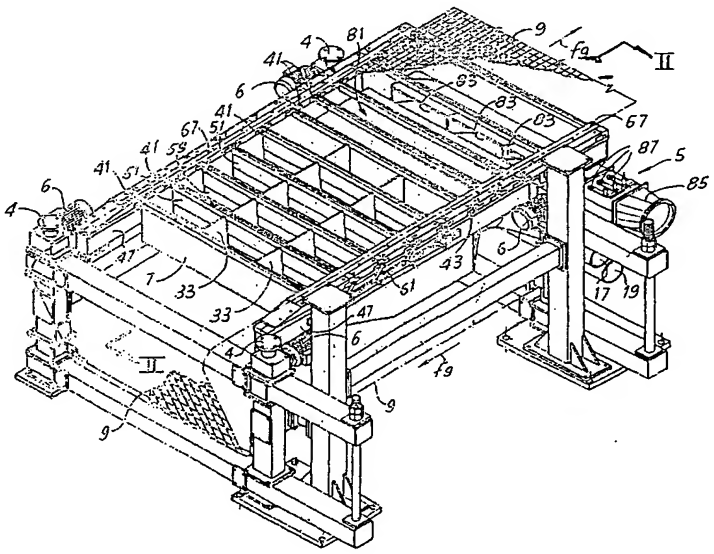
(54) Title: DEVICE FOR DRY-FORMING A WEB OF FIBERS WITH AN INNOVATIVE SUCTION BOX, AND ASSOCIATED METHOD



(57) Abstract: The device comprises: a fiber distribution head (3); a forming wire (9) movable underneath the said head in a feeding direction (f9); a suction box (7) located on the opposite side of the forming wire (9) to the head (3) and connected to a suction system. The suction box (7) is divided transversely with respect to the direction of feeding of the forming wire (9) into at least two longitudinal sections, extending in the direction of feeding of the forming wire. Moreover, control members (29) are envisaged for controlling suction in each of the longitudinal sections in an independent manner with respect to the other longitudinal sections.

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# Device for dry-forming a web of fibers with an innovative suction box, and associated method

## Description

### Technical field

The present invention relates to a device for dry-forming a web of fibers, of the type comprising: a fiber distribution head; a forming wire movable under said head; a suction box located on the opposite side of said forming wire to said head and connected to a suction system.

More particularly, the invention relates to a novel form of suction box for a device of this type.

According to a different aspect, the invention relates to a method for dry-forming a web of fibers.

According to a further aspect, the invention relates to a suction box for a device for dry-forming webs of fibers.

### State of the art

For the production of webs or sheets of fibrous material, in particular paper, absorbent paper or tissue paper, usually methods and machinery are used where a slurry of cellulose fibers is distributed on a forming wire in order to form a thin web. This web is then dried by means of suction of the water and subsequent passing over a heated roller or other drying device.

More recently a new method for the production of paper, in particular absorbent paper of considerable thickness, for example for the production of the hygienic articles, such as baby diapers or sanitary napkins for women, has been introduced. This method envisages the distribution, onto a forming wire or mesh, of a web of fibers supplied by means of an air flow. The method is referred to as an "airlaid" method.

In order to implement the dry-forming method, devices of various types have been designed in order to obtain as uniform as possible a distribution of the fibers and overcome the many drawbacks and problems which this new technique involves.

In general, airlaid web production envisages suspending the fibers in an air flow and depositing them on a forming mesh or wire, beneath which a suction is generated so as to convey the fibers supplied from a forming head

located above. The fibers are distributed in the air flow using various techniques.

A first category of devices envisages the use of a forming head with a screen in the form of a bottom meshwork through which the fibers drawn by a stream of air pass. A forming mesh moves below the meshwork screen which closes the forming head at the bottom and the fibers are deposited thereon so as to form the web. Propellers rotating about a vertical axis, i.e. perpendicular to the forming mesh and to the screen, are arranged above the bottom closing screen of the forming head. The fibers are drawn by an air stream through the closing screen of the head and deposited on the forming mesh. Examples of devices formed in this manner are described in GB-1499687, GB-1559274, US-A-3581706, US-A-4014635, US-A-4157724, US-A-4276248, US-A-4285647, US-4335066, US-A-4351793, US-A-4482308, US-A-4494278, US-A-4627953, US-A-5527171, US-A-5471712, WO-A-9105100, WO-A-9522656, WO-A-9610663, WO-A-9954537 and EP-B-616056.

A second type of device for distributing the fibers in the air flow which is sucked through the forming wire envisages the use of one or more holed ducts with an axis parallel to the forming mesh. The fibers drawn by the air flow emerge from the holes in the ducts and are deposited on the underlying forming mesh which advances in the feeding direction. In EP-A-032772 a forming head of this type is described. A pair of pipes with parallel axes is arranged above the forming mesh. The pipes have holed walls through which the fibers, conveyed by an air flow inside the said pipes, emerge. To allow the fibers to emerge more easily and prevent blockage of the holes, rotating shafts having an axis parallel to the axis of the pipes and equipped with radial tips, are arranged. The latter also have the function of breaking up any lumps of fibers which form in the conveying air flow. Devices based essentially on the same principle are described in US-A-4352649, WO-A-8701403 and EP-B-188454. In these devices the forming head is devoid of the bottom closing screen, and the flow of air and suspended fibers is confined inside the holed-wall ducts, the holed wall having the function of the closing screen of the heads of the first type mentioned above.

US-A-6233787 describes a device for dry-forming a web of fibers in which a head which receives an air flow with the suspended fibers is arranged above the forming wire. The head has underneath a series of rotating shafts or rollers with axes parallel to each other and to the forming mesh, extending transversely with respect to the direction of feeding of the forming mesh. The shafts or rollers have radial tips or stems extending such as to close substantially the bottom opening of the head, forming a kind of pervious wall which allows the passage of the fibers drawn by the air stream sucked from below the forming mesh.

EP-A-159618 describes a device for dry-forming a web of fibers comprising a forming head situated above the forming wire through which the air stream which draws the fibers is sucked. The forming head is closed at the bottom by a fixed screen with perforations so as to allow the fibers to pass through. A plurality of rollers with axes parallel to the forming wire and perpendicular to the direction of feeding of the latter are located above the fixed screen. The rollers are equipped with radial tips and are mounted on a continuous conveyor which causes a translatory movement thereof parallel to the direction of feeding of the forming wire.

A head for forming an airlaid web which is particularly efficient in terms of uniformity of distribution of the fibers is described in the co-pending international patent application number PCT/IT02/00657, filed on 15 October 2002, in the name of the present proprietors.

From the above it is clear that hitherto particular attention has been given to the design of the head for distributing the fibers on the forming wire, in order to obtain the desired uniformity of distribution of the fibers in the final product. Much less attention has been directed, on the other hand, to the design of the suction box which is situated below the forming wire, opposite the head from where the fibers are delivered. Usually the suction box has a very simple form, without special measures which allow the quality of the product leaving the device to be improved.

Objects and summary of the invention

The object of the present invention is to provide a device for the production of a web of fibers, using the so-called airlaid dry technique, which

allows particular advantages to be obtained in terms of uniformity of thickness and distribution of the fibers by means of a particularly advantageous form of the suction box.

These and further objects and advantages, which will become clear to experts skilled in the art from reading of the text which follows, are obtained essentially with a device comprising: a fiber distribution head; a forming wire movable underneath said head in a feeding direction; a suction box located on the opposite side of said forming wire to said head and connected to a suction system. Characteristically, according to the invention: the suction box is divided transversely with respect to the feeding direction of the forming wire into at least two longitudinal sections, extending in the feeding direction. Moreover, control members are envisaged for controlling suction in each of said longitudinal sections in an independent manner with respect to the other longitudinal sections.

In this way it is possible to have a degree of suction, i.e. vacuum, variable from section to section with the consequent possibility of optimizing the distribution profile of the fibers in the transverse direction within the end product. For example, it is possible to compensate for a greater or less flow of fibers from the head situated above by increasing or decreasing the suction in the various sections of the box such that the finished product has the same density of fibers or a same thickness or a same basis weight along the whole cross section.

Vice versa, when it is required to obtain a product which has a non-uniform transverse profile of the basis weight, thickness or density, this may still be obtained by means of a suitable adjustment of suction in the various sections into which the suction box is transversely divided.

The various sections into which the suction box is transversely divided may all be connected to a single suction duct, with the arrangement, in between, of shutter valves or gates, i.e. for reducing the suction cross section, in order to modify the suction conditions inside each section of the box. However, according to a preferred embodiment of the invention, each of said longitudinal sections into which the suction box is transversely divided is connected to its own independent suction duct. A corresponding fan may be

associated with each of these ducts. The possibility of a more efficient and rapid adjustment of the suction in the various sections, for example using an electronic system for controlling the operating conditions of the various motors actuating the individual fans, is thus obtained. When, on the other hand, each longitudinal section of the box is connected by means of a shutter gate or valve to a single suction duct, each gate or valve may be associated with an actuator interfaced with an electronic actuating and control system.

In both cases it is possible to form a control - i.e. feedback - loop by providing a series of sensors which are arranged downstream of the suction box and the head of the forming device and which detect the parameter(s) to be controlled, for example the thickness or the basis weight of the web. On the basis of the signal generated by the sensor or the sensors and a comparison with preset values of the controlled parameter(s), it is possible to generate a feedback signal for adjusting the shutter valves or gates or the actuating motors of the various fans associated with the longitudinal sections into which the suction box is divided. The possibility is not excluded of combining flow-reducing valves or gates with independent suction ducts and motors for the various fans, by envisaging for example a number of fans and suction ducts less than the overall number of sections into which the box is transversely divided, and of dividing one or more of said suction ducts into sections, each equipped with its own shutter valve or gate having its own operating actuator.

Advantageously, the various suction ducts are connected to the respective longitudinal section of the suction box at the end of the suction box which is downstream with respect to the feeding direction of the forming wire. In this way, as clarified below, optimum operation of the suction box is obtained since the sucked-in air flow has a velocity having a component parallel to the feeding direction of the forming wire.

According to a practical embodiment, the suction box is divided into longitudinal sections by longitudinal dividing walls which extend from the bottom of the box up to a height less than the plane of lie of the forming wire. In this way the risk of the web of fibers having a discontinuity opposite each dividing wall is avoided. The distance between the plane of lie of the wire and

the dividing wall is moreover sufficiently small to be able to have different suction conditions in the various longitudinal sections of the suction box.

According to an improved embodiment of the invention, the suction box is further divided into at least two transverse zones arranged one next to the other in the feeding direction of the wire, by means of dividing walls which are transverse (i.e. substantially perpendicular to the feeding direction of the forming wire) and which extend from a zone close to the plane of lie of the forming wire toward the bottom of the suction box, remaining separate from the bottom itself. Moreover, an adjustable shutter member is associated with each of said transverse zones, in order to regulate the flow of air sucked into each of said zones. It is thus possible to increase the efficiency of the entire device.

In fact, considering a single portion of the forming wire, as it passes between the head and the suction box, an increasing quantity of fibers is deposited thereon, said fibers increasing the loss of head in the fiber-conveying gaseous flow (i.e. air stream) which from the inside of the head passes through the wire and is sucked into the suction box, depositing the fibers on the forming wire. In conventional devices this loss of head results in a gradually diminishing efficiency as regards the formation of the web of fibers, since the greater the thickness of the fibers already deposited on the wire, the smaller will be the quantity of fibers which continues to be deposited during the remainder of the movement of the wire through the device. This is the result of the smaller air flow through the forming wire and the web partly already formed thereon, due to the increased loss in head.

Since it is possible to regulate the suction in the transverse sections arranged in succession in the feeding direction of the wire inside the suction box, it is possible to apply a more intense sucking action in the zones of the box situated further downstream with respect to the feeding direction of the forming wire. This gradual increase in the suction compensates for the increased loss of head across the thickness of the fibers which is gradually formed on the forming wire, such that also the final parts of the suction box contribute substantially to the growth of the web of fibers. This allows the

speed of feeding of the forming web and, therefore, ultimately, the productivity of the device to be increased.

It is also possible to adopt this measure of increasing the efficiency of the suction box (by means of division of the box itself into transverse zones) as a sole measure, independently of the division of the box into longitudinal sections. This excludes the advantage of being able to adjust the transverse profile of the basis weight or thickness, but nevertheless there will be an increase in the efficiency of the device in terms of productivity. When the box is divided only by means of the transverse walls into sections or zones arranged in succession in the feeding direction of the forming wire, these transverse dividing walls may also extend as far as the bottom of the box, in which case separate suction ducts will be envisaged for each transverse zone into which the box is divided. In this case it may also be envisaged that the shutter means or members are formed by valves arranged on the suction ducts or independent fans could be envisaged for each transverse zone. An automatic regulating system is, however, not necessary in this case since manual adjustment of the suction conditions in each section or transverse zone of the box at the start of production is sufficient.

In a possible embodiment of the invention, the flow-reducing members associated with the transverse zones into which the suction box is divided each comprise a wall oscillating about a transverse oscillating axis and divided into a number of portions corresponding to the number of longitudinal sections into which the suction box is divided.

Adjustment may be obtained by means of a lever which is associated with each oscillating wall, with locking means for fixing the wall in the desired position.

In a manner known per se, the suction box may have a plurality of transverse profiled parts on which the forming wire rests. These profiled parts may advantageously be interchangeable so that they can be replaced in the event of wear. They may be arranged approximately in correspondence of the transverse dividing walls which divide the box into transverse zones.

Advantageously it is possible to envisage that an auxiliary suction box is arranged downstream of the suction box, with respect to the feeding

direction of the forming wire. Whereas the main suction box extends, in the feeding direction of the forming wire, over a length corresponding to the dimension in this direction of the head of the device, the auxiliary suction box extends beyond the zone acted on by the head of the device and has mainly the function of retaining the web of fibers formed on the forming wire until the web enters into a following station of the production line. The latter may consist of a station for consolidating the fibers or a new fiber distribution device, for forming a second layer of fibers on the web.

The auxiliary suction box may also be divided transversely into longitudinal sections, in a similar manner to that already envisaged for the main suction box. Each of these sections, which may be defined by a respective suction mouth, may have associated with it a suction regulating member for regulating the suction in an independent manner for the various mouths and therefore for the various longitudinal sections into which this auxiliary box is divided.

According to a different aspect, the invention envisages a method for dry-forming a web of fibers, comprising the steps of:

- generating fibers suspended in a gaseous flow, typically air;

- generating suction of said gaseous flow across a forming wire onto which said fibers are deposited, forming the web.

Characteristically, according to the invention, it is envisaged to divide up the suction transversely with respect to the feeding direction into longitudinal sections extending parallel to the feeding direction of the forming wire and regulating the suction in each of said longitudinal sections in an independent manner with respect to the other longitudinal sections.

Further advantageous features and embodiments of the device and the method according to the invention are indicated in the accompanying dependent claims.

The invention also relates to a suction box for a device for dry-forming a web of fibers, comprising a forming wire advancing in a machine direction, characterized in that it is divided up transversely with respect to the machine direction into at least two longitudinal sections, extending in the machine direction; and in that control members are envisaged for controlling the

suction in each of said longitudinal sections in an independent manner with respect to the other longitudinal sections.

Brief description of the drawings

The invention will be better understood with reference to the description and the attached drawing which shows a practical non-limiting embodiment of the invention. In particular, in the drawing, where identical numbers indicate identical or corresponding parts:

- Figure 1 shows a side view of the device;
- Figure 2 shows a longitudinal section, along II-II of Figure 3, through the main suction box and the auxiliary suction box;
- Figure 3 shows a perspective view of the suction box with the forming wire partly removed;
- Figure 4 shows a front view along IV-IV of Figure 2;
- Figure 5 shows a cross section along V-V of Figure 2;
- Figure 6 shows an enlargement of the detail indicated by VI in Figure 5;
- Figure 7 shows a section along VII-VII in Figure 6;
- Figure 8 shows a section along VIII-VIII in Figure 4;
- Figure 9 shows a local section along IX-IX of Figure 5; and
- Figure 10 shows a local section along X-X of Figure 5.

Detailed description of the preferred embodiment of the invention

Figure 1 shows in its entirety a device for dry-forming (using the so-called airlaid technique) a web of fibers, for example cellulose fibers. The device, denoted overall by 1, comprises an upper part or head, denoted overall by 3, and a bottom part 5 which comprises among other things, as the main element, a suction box 7. A forming wire 9, on which the web of fibers schematically indicated by 11 is formed, passes between the head 3 and the suction box 7 (see Fig. 1).

The forming wire 9 defines a closed path, of which only a portion delimited by two drive rollers 13 and 15, is shown in Figure 1. The direction of feeding of the wire along this path is indicated by the arrow f9. The arrow f9 also defines the so-called machine direction, i.e. the direction along which the material being formed advances.

The configuration of the forming head 3 may be of any nature and advantageously may be formed as described in the international patent application PCT/IT02/000657 in the name of the present proprietors. It must however be understood that other configurations of the head are possible since the advantages that the suction head according to the present invention has may be used with equivalent results as regards the increase in the quality of the product and the productivity also in combination with forming heads of the traditional type. Generally the characteristics of the suction box may be combined with heads formed in accordance with various techniques, such that the specific structure of the head 3 is not of relevance in the description of the present invention and consequently will not be illustrated here.

The head 3 rests on the structure of the underlying part at four support points 4 (see in particular Figures 1 and 3), the height of which may be adjusted by means of motorized jacks 6.

As can be seen in particular in the section according to Figure 2, the suction box 7 has a bottom which is at least partly inclined from the top downward in the feeding direction of the forming wire 9. At the downstream end (with respect to the feeding direction of the wire 9) the suction box 7 is connected to three suction ducts indicated by 17, 19 and 21. The three suction ducts are connected to three corresponding fans, each equipped with its own motor, shown only schematically in Figure 4 and designated here as 23, 25 and 27. The three motors of the fans 23, 25 and 27 are connected to a central control unit which is schematically indicated by 29, in turn connected to a sensor or to a series of sensors schematically indicated by 31 and arranged downstream of the head 3 of the device 1 along the path of the forming wire 9, for detecting the thickness or basis weight of the web 11 leaving the device. This arrangement allows the device to be controlled in a manner which will be described below. Basically a linear array or matrix of sensors may be envisaged for detecting the progression of the transverse profile (i.e. in a direction perpendicular to the feeding direction of the forming wire 9) of one or more parameters, such as the basis weight, the thickness, the density or another parameter, of the web 11 formed by the device 1.

Each of the three suction ducts 17, 19, 21 is connected to a respective longitudinal section into which the suction box 7 is divided by longitudinal dividing walls 33. As can be seen in particular in the cross section according to Figure 2 and Figure 5, these dividing walls extend from the bottom of the suction box 7 up to a height which does not reach the plane of lie of the forming wire 9. In this way three longitudinal sections, arranged alongside each other in the transverse direction, i.e. perpendicular to the feeding direction of the forming wire 9, are created inside the suction box 7. In each of the three longitudinal sections it is possible to establish a suction condition which can be regulated independently of the suction conditions in the remaining longitudinal sections, by increasing or reducing the flow rate of the corresponding fan 23, 25 or 27.

When the device is in operation, a flow of air containing, suspended, the fibers intended to form the web on the forming wire 9, is generated between the forming head 3 and the suction box 7. This flow is sucked through the structure of the forming wire 9 owing to the vacuum conditions created inside the suction box 7 and the fibers are deposited on the wire itself. By increasing or reducing the suction inside each of the three longitudinal sections into which the suction box is divided by means of the walls 33, it is possible to increase or reduce the flow rate of this flow and therefore the quantity of fibers which are deposited along three longitudinal sections into which the forming wire is ideally divided opposite the longitudinal sections into which the suction box 7 is divided.

It must be understood that the number of longitudinal sections into which the suction box 7 is divided may also be different from three. For example, it is possible to envisage four, five or more longitudinal sections. It is also possible to envisage a division into only two longitudinal sections. By increasing the number of sections into which the box is divided by means of the longitudinal walls 33, the complexity of the suction box is increased, but on the other hand the possibility of modulating the suction conditions in the transverse direction - and therefore of obtaining with greater precision the desired transverse profile, i.e. the desired progression, in the transverse

direction, of the controlled parameter, for example the thickness, the basis weight or the density of the web formed - are also increased.

By means of the thickness or basis weight sensors 31, it is possible to detect the transverse profile, i.e. the progression, in the transverse direction, of the parameter detected (thickness, basis weight or other parameter of the web 11 being formed) and transmit the values detected to the central control unit 29. These values may be compared with preset values of said parameter which may also be modified by the operator. On the basis of an error signal generated from this comparison, it is possible to modify the suction conditions of the fans 23, 25 and 27. In this way it is possible to keep the thickness or the basis weight substantially constant in the transverse direction of the web 11. Alternatively it is possible to produce a web which has a transverse profile with a thickness or basis weight or density which is variable as required, for example a greater thickness or a greater basis weight in one of its longitudinal sections and a smaller thickness or smaller basis weight in a different longitudinal section.

As can be observed in particular in the cross section according to Figure 2, since the suction ducts 17, 19 and 21 are connected to the suction box 7 at the downstream end of the latter with respect to the feeding direction of the forming wire 9, inside the suction box 7 a sucked air flow which has a component parallel to the direction of feeding ~~f~~9 of the forming wire is generated. This facilitates the distribution of the fibers contained in the flow and supplied by the head 3.

In the region of the suction box 7 the forming wire 9 is supported by a plurality of transverse profiled parts 41 shown in detail in the cross sections according to Figures 9 and 10. Each profiled part 41 is supported at its ends by respective blocks 43 screwed by means of screws 45 to the support frame of the suction box 7, two longitudinal beams of which are indicated by 47. As can be seen in the cross section according to Figure 2, transverse walls 51 are provided in correspondence of four of the profiled parts 41, said walls dividing the suction box 7 into five transverse zones which are arranged in succession in the longitudinal moving direction of the forming wire 9. The four transverse walls 51 are supported by cross-pieces 53 also fastened to the

blocks 43. The transverse dividing walls 51 have a downward extension which is relatively limited and extend over an intermediate height, remaining with their bottom edge at a considerable distance from the bottom of the suction box 7. This is so in order to avoid obstruction of the suction through the suction ducts 17, 19, 21.

Parallel to each of the transverse walls 51 and parallel to the vertical transverse portion of the external wall defining the suction box 7, there extend axes 57 for supporting and mounting in an oscillating manner five gates or walls 59 able to assume, rotating about the axis 57, different angular positions ranging between a vertical position illustrated in Figure 2 and a horizontal position. Each wall 59 is formed by three portions aligned along the axis 57. These portions arranged next to each other define slits in the walls 59 at the points corresponding to the longitudinal dividing walls 33 which divide the suction box 7 into the three longitudinal sections.

Depending on the angular position assumed by each wall 59, independently of the other partitions, the suction cross section between two consecutive transverse walls 51 - or between one of the said transverse walls and the external transverse wall of the suction box 7 - may be varied. In this way, the area located underneath the forming wire 9 and corresponding to the suction box 7 is divided into five transverse zones in each of which the suction may be reduced to a greater or lesser degree compared to the other adjacent transverse zones.

The oscillating movement of the walls 59 is controlled by means of levers 61, each of which may be fixed in a predetermined angular position independent of the angular positions in which the remaining levers 61 are fixed. This allows manual adjustment of the flow reduction of each of the transverse zones into which the suction box is divided. Manual adjustment of the flow reduction is sufficient for the purposes for which this adjustment is intended. In fact, contrary to the division into longitudinal sections, which is used to obtain a continuous adjustment, with a feedback loop, of the thickness or the basis weight of the web produced, the division of the suction box 7 into transverse zones has solely the purpose of modulating the suction from the zone further upstream to the zone further downstream of the suction

box along the feeding direction of the forming wire 9, in order to compensate for the greater drop in pressure which occurs through the assembly formed by the wire and by the layer of fibers being produced thereon.

Therefore the transverse zone of the suction box 7 further downstream, where there is maximum thickness of the fibers, will be completely open, i.e. the corresponding wall 59 will be normally in the vertical position. The remaining walls of the transverse zones situated in each case further upstream will be gradually more and more closed, i.e. more inclined with respect to the vertical. The wall 59 hinged in the vicinity of the rear external wall of the suction box will be the wall which is normally in the most closed position.

Manual setting of these different degrees of flow reduction is normally sufficient, although it is possible to envisage the possibility of modifying these flow reduction conditions for example when the type of fiber used changes. It is moreover possible to provide automatic or in any case servo-assisted adjustment of the flow reduction of the transverse zones of the box.

As can be seen in particular in the cross sections according to Figures 7, 9 and 10, the configuration of the blocks 43 for supporting the profiled parts 41 and for locking the axes 57, as well as of the cross-pieces 53 supporting the walls 59 and the transverse walls 51, is such that replacement of the worn profiled parts 41 may be performed without disassembling the walls 51 and the walls 59. It is in fact sufficient to unscrew the screws 45 which lock the corresponding block 43 onto one of the two sides of the suction box and extract the block itself so as to allow removal of the worn profiled part 41 and its replacement with a new profiled part which will be locked in position by means of reinsertion of the block 43.

In addition to the blocks 43 and in alternate positions with respect to the latter, inserts 44 are also fastened onto the longitudinal beams 47. The inserts 44 and the blocks 43 form respective continuous longitudinal surfaces on the two sides of the suction box 7 onto which a steel plate 67 is fixed, on which plate the forming wire 9 rests and slides with its longitudinal edges. These plates can be interchanged without disassembling the remaining parts

of the structure and in any case have a limited degree of wear owing to the hardness of the material from which they are made.

An auxiliary suction box, which is denoted overall by 81, is arranged downstream of the suction box 7, in the feeding direction of the forming wire 9. As can be seen in particular in the perspective view according to Figure 3, on the downstream side, with respect to the direction of feeding of the forming wire 9, in the auxiliary suction box 81 three suction mouths 83 emerge, arranged next to each other in the transverse direction, i.e. perpendicularly with respect to the direction of feeding of the forming wire 9. The interior of the auxiliary suction box 81 is not divided into longitudinal sections by dividing walls, as envisaged - vice versa - for the main suction box 7. However, the presence of three suction mouths arranged alongside each other allows (by varying the suction conditions in each of the said mouths) to have suction conditions which are variable in the transverse direction of the chamber.

The three suction mouths 83 are connected to a single suction duct 85 by means of three shutter valves or gates, schematically indicated by 87 (see in particular Figures 3 and 4). The valves 87 may be adjusted manually or automatically. Also, in the auxiliary suction box 81, the forming wire 9 is supported by profiled parts 41 in a similar manner to that envisaged in the main suction box 7.

It is understood that the drawing shows only one possible embodiment of the invention, the forms and arrangements of which may vary without thereby departing from the idea forming the basis of the invention. The presence of any reference numbers in the accompanying claims has solely the purpose of facilitating reading thereof in the light of the preceding description and the accompanying drawings and does not limit in any way the protective scope thereof.

## Claims

1. A device for dry-forming a web of fibers (11) comprising: a fiber distribution head (3); a forming wire (9) movable underneath said head in a feeding direction (f9); a suction box (7) located on the opposite side of said forming wire (9) to said head (3) and connected to a suction system;

**characterized in that**

- said suction box (7) is divided transversely with respect to the feeding direction of the forming wire (9) into at least two longitudinal sections, extending in the feeding direction of the forming wire;

- and control members (29) are envisaged for controlling suction in each of said longitudinal sections in an independent manner with respect to the other longitudinal sections.

2. Device according to Claim 1, characterized in that each of said longitudinal sections is connected to a suction duct (17, 19, 21) which is separate with respect to the other longitudinal sections.

3. Device according to Claim 2, characterized in that a fan (23, 25, 27) is associated with each of said suction ducts.

4. Device according to Claim 2 or 3, characterized in that each of the said suction ducts is connected to the respective longitudinal section of the suction box at the end of the suction box which is downstream with respect to the feeding direction of said forming wire (9).

5. Device according to one or more of the preceding claims, characterized in that at least one sensor (31) which determines the transverse profile of at least one characteristic of the fiber web (11) is arranged downstream of said suction box, the suction in said longitudinal sections being regulated according to the said transverse profile.

6. Device according to Claim 5, characterized in that it comprises a central control unit connected to said sensor and to said suction control members.

7. Device according to Claim 4 or 5 or 6, characterized in that said characteristic, the transverse profile of which is detected by the sensor, is the thickness of the web of fibers.

8. Device according to Claim 4 or 5 or 6, characterized in that said characteristic, the transverse profile of which is detected by the sensor, is the basis weight of the web of fibers.

9. Device according to one or more of the preceding claims, characterized in that said suction box (7) is divided into said longitudinal sections by longitudinal dividing walls (33) which extend from the bottom of the box up to a height less than the plane of lie of said forming wire (9).

10. Device according to one or more of the preceding claims, characterized in that said suction box is further divided into at least two transverse zones by means of dividing walls (51) which are transverse to the feeding direction of the forming wire and which extend from a zone close to the plane of lie of the forming wire toward the bottom of the suction box, remaining separate therefrom.

11. Device according to Claim 10, characterized in that an adjustable flow-reducing member (59) is associated with each of said transverse zones, in order to regulate the flow of air sucked into each of said transverse zones.

12. Device according to Claim 11, characterized in that each of said flow-reducing members comprises a wall (59) oscillating about an oscillating axis (57) and divided into a number of portions corresponding to the number of longitudinal sections into which the suction box is divided.

13. Device according to Claim 12, characterized in that an adjusting lever (61) and means for locking the adjusting lever in a selected position are associated with each oscillating wall.

14. Device according to Claim 12 or 13, characterized in that each of said oscillation axes lies approximately in correspondence of a transverse dividing wall and extends parallel thereto.

15. Device according to one or more of the preceding claims, characterized in that said suction box has a plurality of transverse profiled parts (41) for supporting the forming wire.

16. Device according to Claim 15, characterized in that said transverse profiled parts are interchangeable.

17. Device according to Claims 10 and 15, or 10 and 16, characterized in that said transverse profiled parts (41) are arranged approximately in correspondence said transverse dividing walls (51).

18. Device according to Claim 16 or 17, characterized in that each of said interchangeable profiled parts (41) is fixed by means of a pair of blocks (43) which can be disassembled and are fixed along the longitudinal edges of said suction box.

19. Device according to Claims 10, 12, 14 and 18, characterized in that each pair of blocks fixes a respective transverse dividing wall and a respective oscillation axis of a corresponding flow-reducing member.

20. Device according to one or more of the preceding claims, characterized in that the cross section of said box increases gradually from upstream to downstream in the feeding direction of said forming wire.

21. Device according to one or more of the preceding claims, characterized in that an auxiliary suction box (81) is arranged downstream of said suction box, with respect to the feeding direction of said forming wire.

22. Device according to Claim 21, characterized in that said auxiliary suction box is associated with a plurality of suction mouths (83) which generate suction flows in the feeding direction of the forming wire.

23. Device according to Claim 22, characterized in that the number of said suction mouths is equal to the number of longitudinal sections into which the suction chamber (7) is divided.

24. Device according to Claim 22 or 23, characterized in that a suction regulating member (87) for regulating the suction in an independent manner for the various mouths is associated with each suction mouth.

25. Device according to Claim 24, characterized in that said suction mouths are connected to a single auxiliary suction duct (85) and a valve with adjustment which is independent from the valves of the other suction mouths associated with each of them.

26. A method for dry-forming a web of fibers, comprising the steps of:

- generating a fiber suspension in a gaseous flow;

- generating a suction of said gaseous flow across a forming wire onto which said fibers are deposited, forming said web, said wire moving in a feeding direction;

**characterized by** dividing the suction, transversely with respect to the feeding direction, into longitudinal sections extending parallel to the feeding direction and regulating the suction in each of said longitudinal sections in an independent manner with respect to the other longitudinal sections.

27. Method according to Claim 26, characterized by detecting a transverse profile of at least one characteristic of the fiber web formed on said forming wire and regulating the suction in each of said longitudinal sections depending on said transverse profile.

28. Method according to Claim 27, characterized in that said characteristic is the thickness of the web.

29. Method according to Claim 27, characterized in that said characteristic is the basis weight of the web.

30. Method according to Claim 27, 28 or 29, characterized by:

- setting a suction condition for each of said longitudinal sections;
- detecting said transverse profile;
- comparing said transverse profile detected with a preset transverse profile;
- generating a feedback signal for modifying the suction conditions in one or more of said longitudinal sections on the basis of the difference between the transverse profile detected and the preset transverse profile.

31. Method according to one or more of Claims 26 to 30, characterized by dividing up the zone situated underneath said forming wire into a plurality of transverse zones arranged alongside each other and adjusting the suction conditions in each of said transverse zones.

32. Method according to Claim 31, characterized by adjusting the suction conditions in each of said transverse zones so as to compensate for the greater drop in pressure of the gaseous flow in the feeding direction of the forming wire owing to the accumulation of fibers on the said wire.

33. Method according to Claim 31 or 32, characterized reducing the suction across each of said transverse zones in a decreasing manner in the feeding direction of the forming wire.

34. A suction box (7) for a device for dry-forming a web of fibers, comprising a forming wire advancing in a machine direction, **characterized in that**

- it is divided up transversely with respect to the machine direction into at least two longitudinal sections, extending in the machine direction;
- and in that control members (29) are envisaged for controlling the suction in each of said longitudinal sections in an independent manner with respect to the other longitudinal sections.

35. Suction box according to Claim 1, characterized in that each of said longitudinal sections is connected to a suction duct (17, 19, 21) which is separate from the other longitudinal sections.

36. Suction box according to Claim 35, characterized in that a fan (23, 25, 27) is associated with each of said suction ducts.

37. Suction box according to Claim 35 or 36, characterized in that each of said suction ducts is connected to the respective longitudinal section of the suction box at the downstream end of the suction box with respect to the feeding direction of said forming wire (9).

38. Suction box according to one or more of Claims 34 to 37, characterized in that it is divided up into said longitudinal sections by longitudinal dividing walls (33) which extend from the bottom of the box up to a height lower than the plane of lie of said forming wire (9).

39. Suction box according to one or more of Claims 34 to 38, characterized in that it is further divided up into at least two transverse zones, by means of dividing walls (51) which are transverse to the machine direction and which extend from a zone close to the plane of lie of the forming wire toward the bottom of the suction box, remaining separate therefrom.

40. Suction box according to Claim 39, characterized in that an adjustable flow-reducing member (59) is associated with each of said transverse zones, for regulating the flow of air sucked into each of said transverse zones.

41. Suction box according to Claim 40, characterized in that each of said flow-reducing members comprises a wall (59) oscillating about an

oscillation axis (57) and divided into a number of portions corresponding to the number of longitudinal sections into which the suction box is divided.

42. Suction box according to Claim 41, characterized in that an adjusting lever (61) and means for locking the adjusting lever in a selected position are associated with each oscillating partition.

43. Suction box according to Claim 41 or 42, characterized in that each of said oscillation axes lies approximately in correspondence of a transverse dividing wall and extends parallel thereto.

44. Suction box according to one or more of Claims 34 to 43, characterized in that said suction box has a plurality of transverse profiled parts (41) for supporting the forming wire.

45. Suction box according to Claim 44, characterized in that said transverse profiled parts are interchangeable.

46. Suction box according to Claims 39 and 44 or 39 and 45, characterized in that said transverse profiled parts (41) are arranged approximately in correspondence of said transverse dividing walls (51).

47. Suction box according to Claim 45 or 46, characterized in that each of said interchangeable profiled parts (41) is fixed by means of a pair of blocks (43) which can be disassembled and are fixed along the longitudinal edges of said suction box.

48. Suction box according to Claims 39, 41, 43 and 47, characterized in that each pair of blocks fixes a respective transverse dividing wall and a respective oscillating axis of a corresponding flow-reducing member.

49. Suction box according to one or more of Claims 34 to 48, characterized in that the cross section of said box increases gradually from upstream to downstream in the feeding direction of said forming wire.

50. Suction box according to one or more of Claims 34 to 49, characterized in that it is associated with an auxiliary suction box (81) arranged downstream of said suction box with respect to the feeding direction of said forming wire.

51. Suction box according to Claim 50, characterized in that said auxiliary suction box is associated with a plurality of suction mouths (83) which generate suction flows in the feeding direction of the forming wire.

52. Box according to Claim 51, characterized in that the number of said suction mouths is equal to the number of longitudinal sections into which the suction box (7) is divided.

53. Suction box according to Claim 51 or 52, characterized in that a suction regulating member (87) for regulating the suction independently for the various mouths is associated with each suction mouth.

54. Suction box according to Claim 53, characterized in that said suction mouths are connected to a single auxiliary suction duct (85) and each of them has associated with it a valve with adjustment independent from that of the other suction mouths.

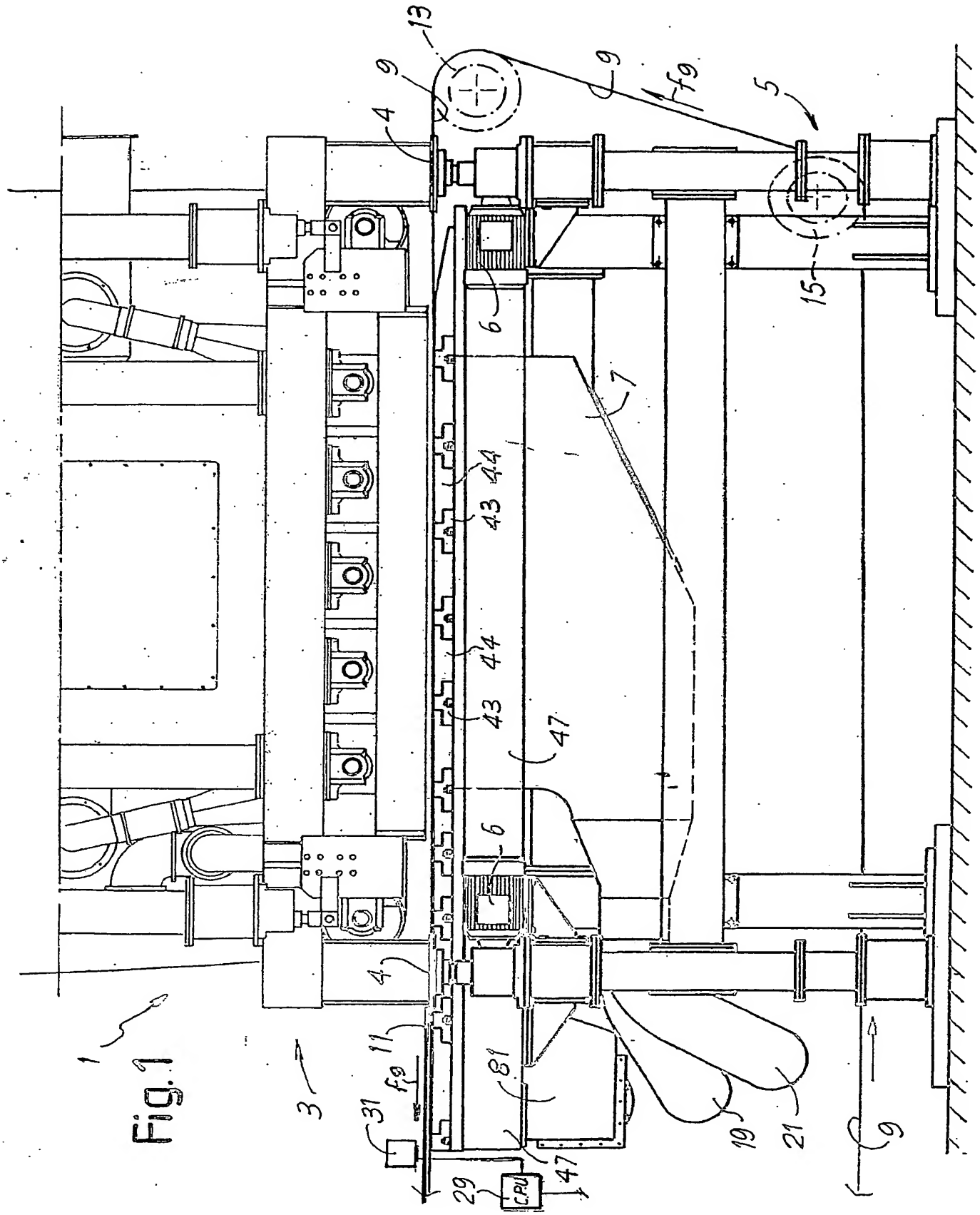



Fig.1

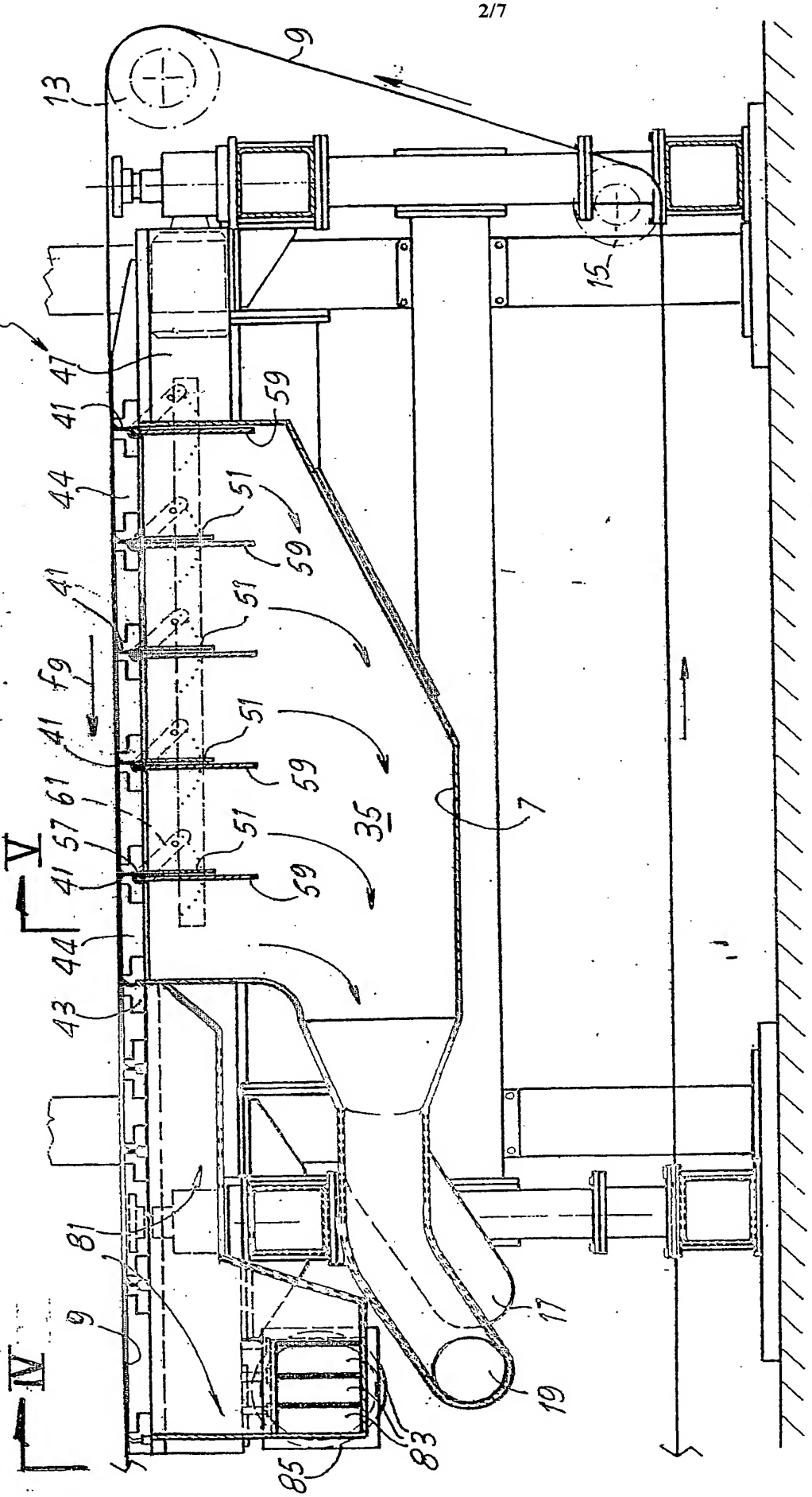
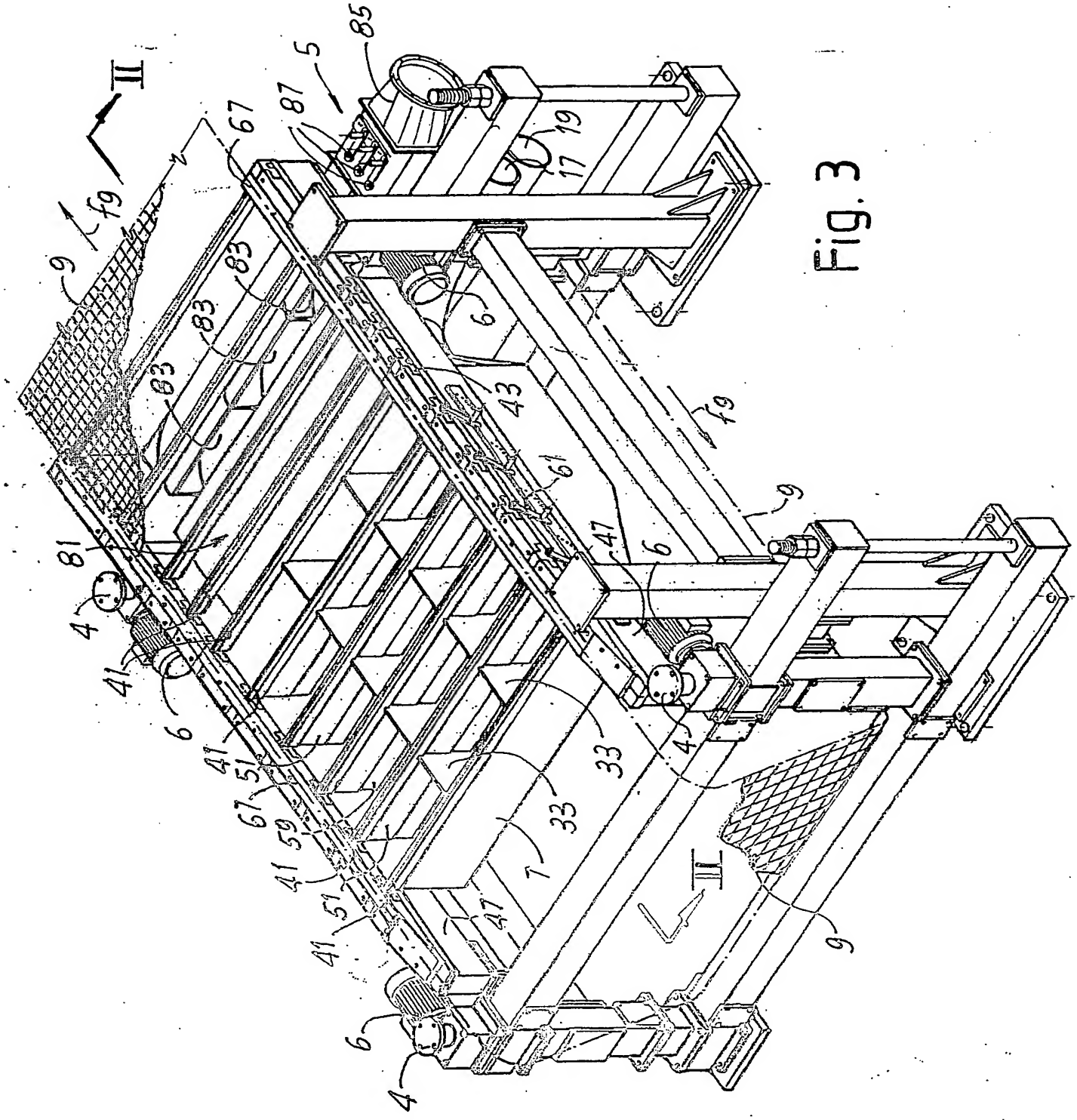



Fig. 2

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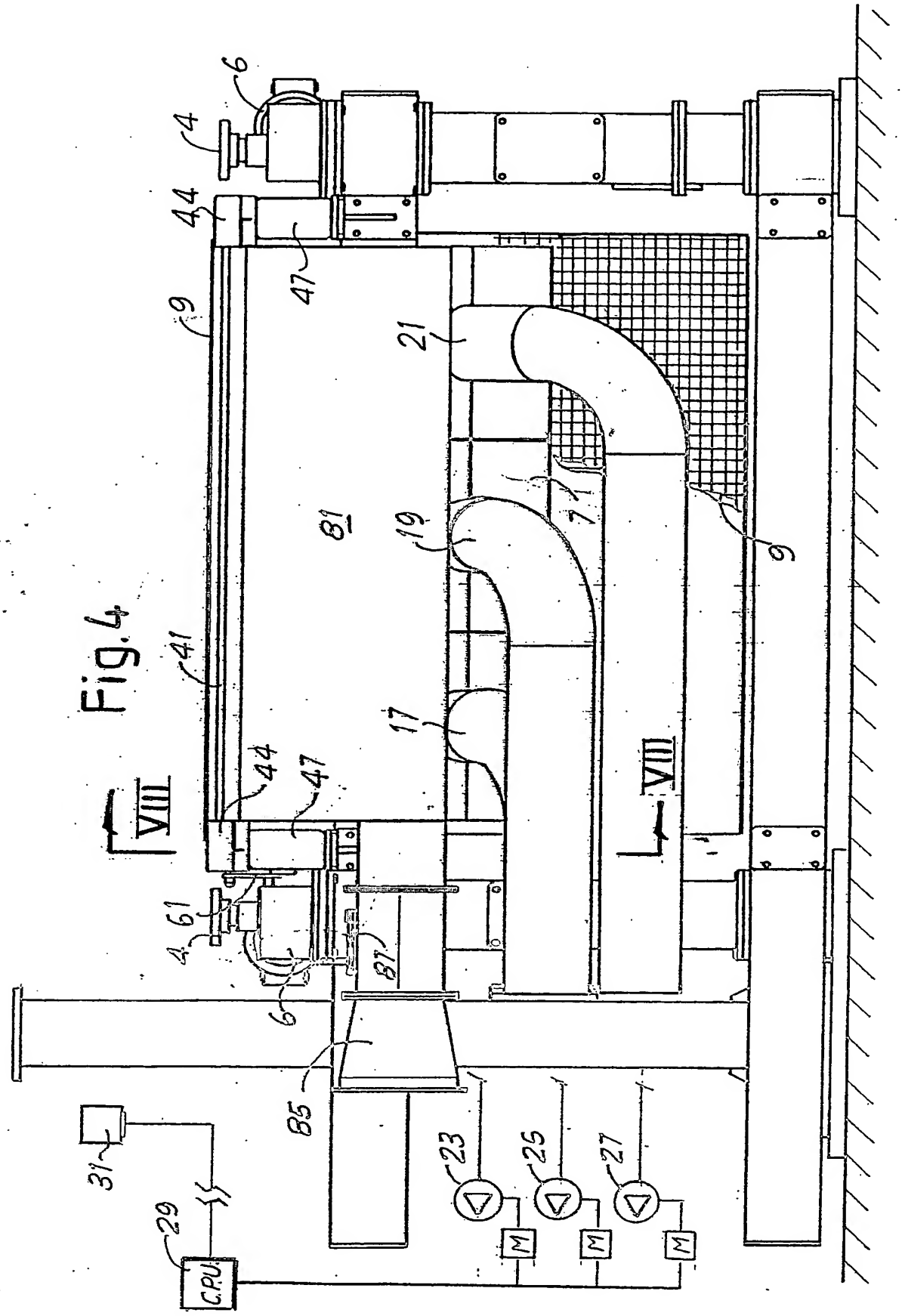
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VIII
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Fig. 4

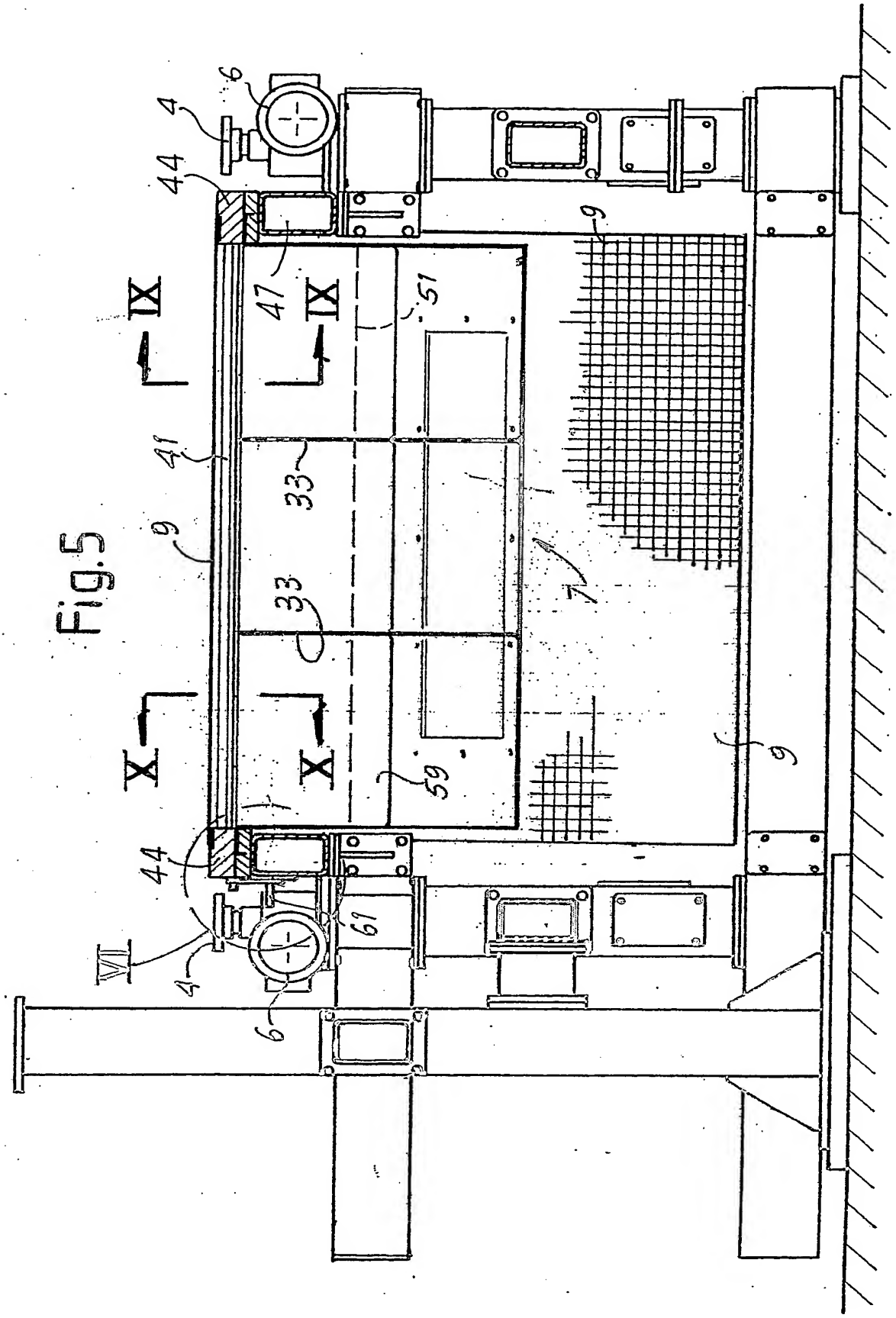


Fig.5

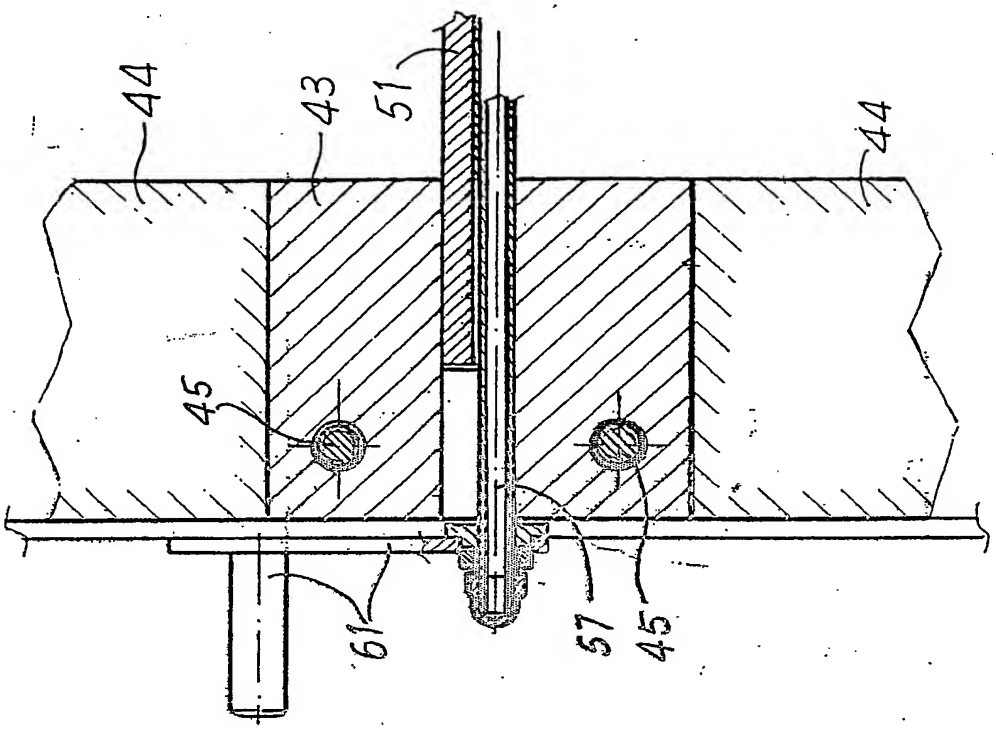


Fig. 7

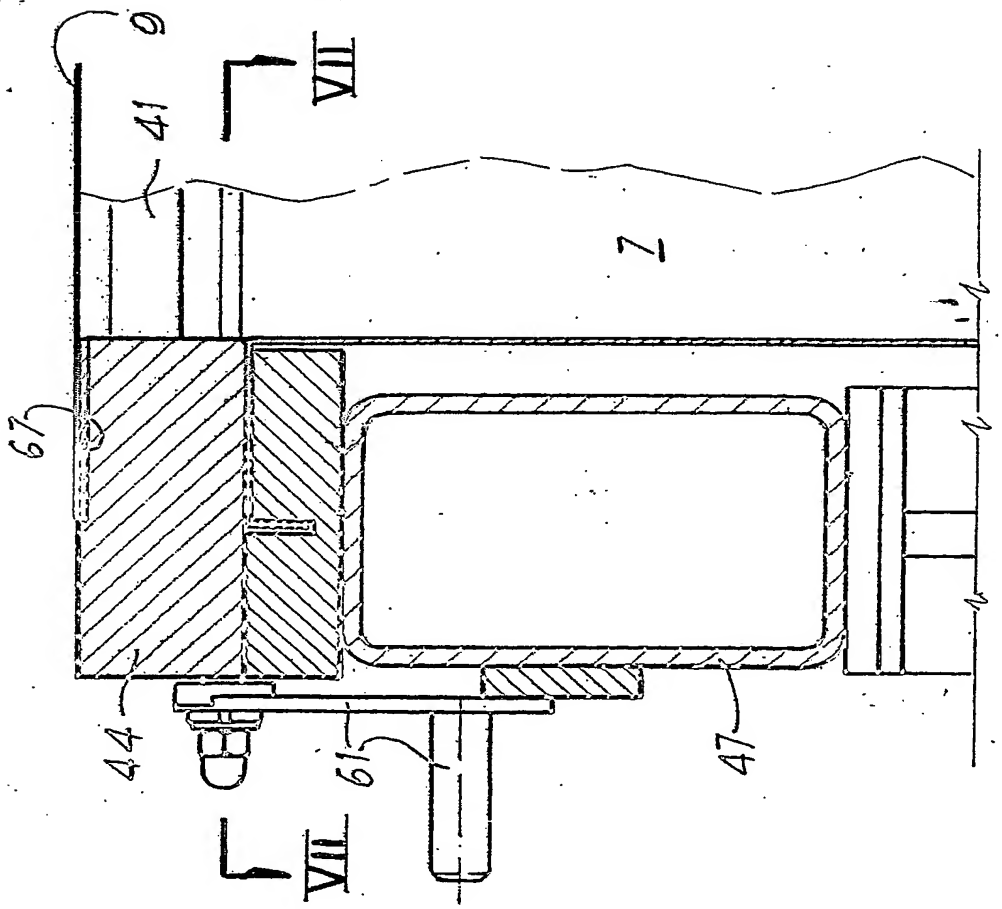


Fig. 6

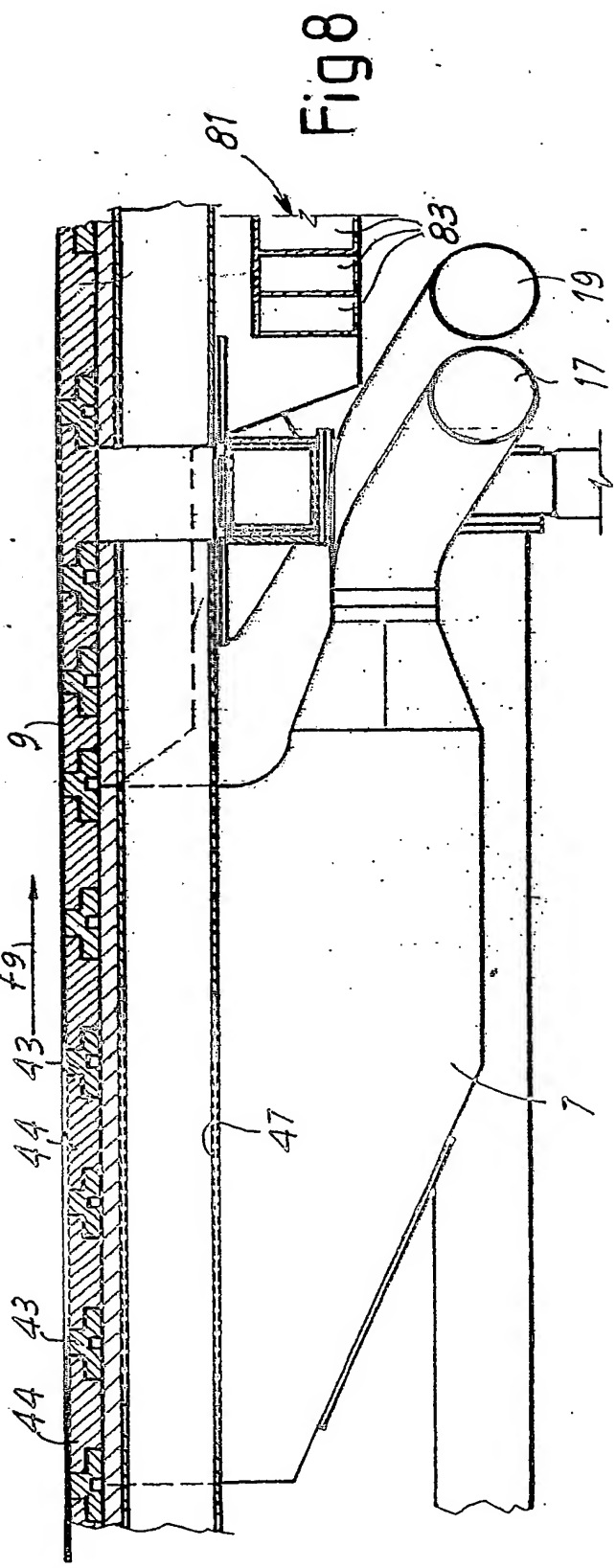


Fig8

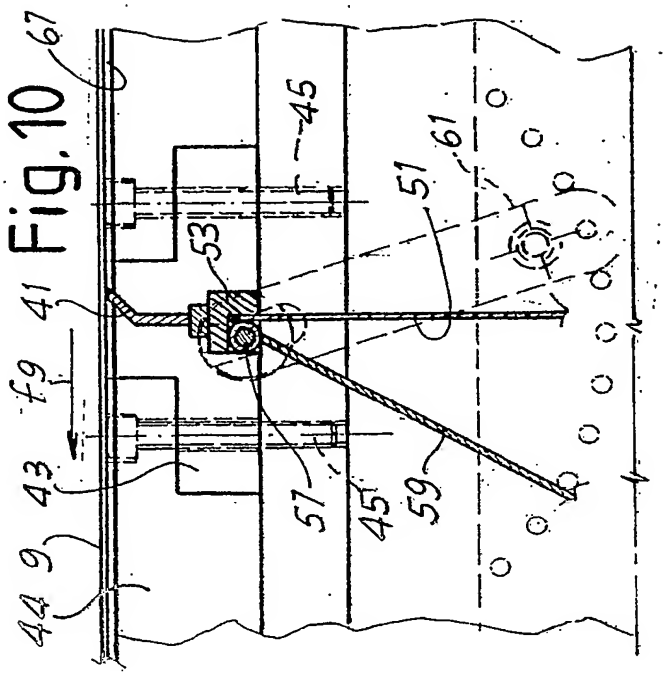


Fig.10

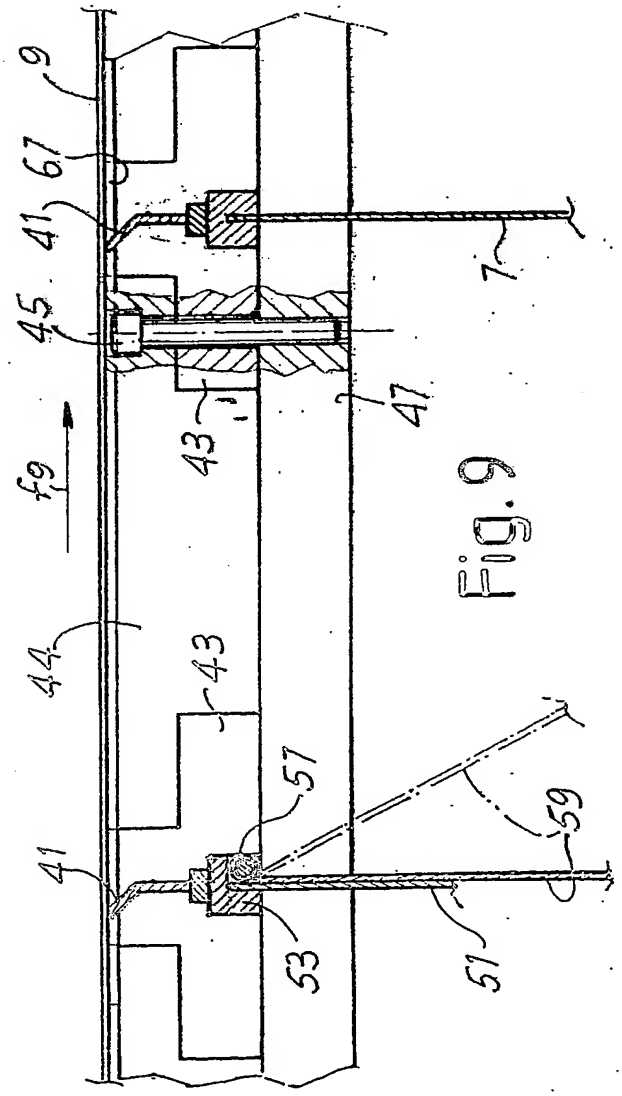


Fig.9

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/IT 03/00020

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D21F1/00 D04H1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D21H D21F D04H A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 23 September 2003 | 07/10/2003 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL – 2280 HV Rijswijk<br>Tel. (+31–70) 340–2040, Tx. 31 651 epo nl,<br>Fax: (+31–70) 340–3016 | Gast, D |

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